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Money and Prices: A Statistical Study of Price Movements. A dissertation submitted to the faculty of the graduate school of arts and literature of the University of Chicago in candidacy for the degree of doctor of philosophy. By James Dysart Magee. Chicago: The University of Chicago. Reprinted, with additions, from the Journal of Political Economy, Vol. XXI, Nos. 8 and 9. 1913. Pp. 89.

Money and Prices is an inconclusive study based upon unreliable statistical methods.

In the words of the author the object of the study is to test "the relationship which exists between certain price changes and certain changes in amounts of money. Then the question arises of how this narrower problem is related to the discussion over the validity of the Quantity Theory of Money, which is the principal point of difference in the discussions of momentary theory at the present time. . . . Perhaps the opponents of the Quantity Theory of Money are talking about what actually happens and the adherents merely about a hypothetical state of affairs. Our problem then may be stated in alternative ways: we are attempting to find out how far the alleged proportionality does occur; or, we are attempting to find out to what extent 'other things' are not 'equal' in actual experience." (Pp. 11, 12.) In solving this problem Dr. Magee makes three classes of investigation as follows: "First a study is made of the correspondence of certain particular price movements in given markets with the movement of money or deposits in banks or money in circulation. . . . The second type of investigation concerns the relation of movements in the amount of money to the movements of wholesale prices. . . . The third type of investigation examines certain attempts at statistical proofs of the Quantity Theory of Money. These proofs make allowances for the factors omitted from what we have called the crude theory." (Pp. 12–15.)

The statistical method used by Dr. Magee in making his tests was explained in his article on "The degree of correspondence between two series of index numbers" in the QUARTERLY PUBLICATIONS for June, 1912. In that article he objects to the use of the Pearsonian coefficient of correlation as a means of testing the relationship between two series of index numbers because (1) "it entirely disregards the element of time which in most problems in which index numbers are used, is of prime importance"; and (2) "a given quantity may be added to or subtracted from the terms of our series without changing the value of the correlation coefficient."

The first objection does not hold if we use Mr. R. H. Hooker's method of computing the correlation coefficient from the "differences between successive values of the two variables." ("On the correlation of successive observations," Journ. Roy. Stat. Soc., Vol. 68, p. 697; see also the reviewer's "The correlation of economic statistics," QUARTERLY PUBLICATIONS OF THE AMERICAN STATISTICAL ASSOCIATION, December, 1910.) Concerning this method Mr. Hooker says that ''correlation of the difference between successive values will probably prove most useful where the similarity of the shorter rapid changes (with no apparent periodicity) are the subject of the investigation, or where the normal level of one or both series of observations does not remain constant.'' (*Ibid.*, p. 703.) G. Udny Yule uses Hooker's method of differences in measuring the correlation between the annual infantile mortality per 1,000 births and general mortality per 1,000 living. (See Yule's Theory of Statistics, p. 197.) The method of differences accomplishes two results: (1) it reduces, although it does not entirely eliminate, the influence of the growth element on the coefficient; and (2) it has the effect of making the *order in time* of the items of significance.

Dr. Magee's second objection to the coefficient of correlation as stated above calls attention to a virtue, not a defect, of the coefficient. That ''the correlation coefficient of two series of index numbers is not changed if we add a constant to each term of one series'' is true. But that this fact ''is perhaps the strongest argument against using it for testing the relationship between two sets of index numbers'' is decidedly untrue. Suppose that we are using the ordinary graphic method of comparing the fluctuations of two series of index numbers, each series represented by a graph with time as abscissas. If the ordinates are such that one graph is so far below the other that comparison is difficult we shift the former upward or the latter downward for convenience in comparing the fluctuations. This graphic process is identical with the algebraic process of adding or subtracting a constant to or from, as the case may be, each term of the series. It may be said, indeed, that any method of measuring correlation which does not have the mathematical property to which Dr. Magee objects is erroneous.

As a substitute for the coefficient of correlation the author suggests that the two series be treated as follows: First, multiply each item of one of the two series by such a multiplier as to make the initial items of the two series identical. ''Next,'' he says, ''we may get the amount of change in each case and take as the degree of correspondence the fraction which has the smaller change for the numerator and the larger change for the denominator. . . . By treating each successive change in this manner and then taking the arithmetic mean of the results we obtain what may be called the Degree of Correspondence. . . .'' Thus, in comparing the two series: 2, 4, 6, 8, 10 and 5, 10, 15, 20, 25, Dr. Magee would multiply the items of the first series by 5-2, obtaining a series identical (in this case) with the second series. For this pair of series the fractions are all 1 and the arithmetic mean of the fractions, or the ''Degree of Correspondence,'' is therefore 1.

The author uses this method throughout his investigation to test the relationship between weekly, monthly, and yearly, (1) price indices for bonds, stocks, farm products, certain speculative commodities, and wholesale prices of commodities on the one hand, and (2) specie and legal tenders in the New York clearing house banks, net deposits, and per capita and total circulation on the other hand. Finally, he applies the same method to the figures obtained by Kemmerer and Fisher as his (Dr. Magee's) test of the truth of the quantity theory of prices. As a matter of fact, however, in more than nine tenths of the cases the author was contented to take +1 in case the changes of the corresponding items were in the same direction, and —1 in case they were in opposite directions, giving the arithmetic average of the algebraic sum as his ''Degree of Correlation.'' Out of some 114 tests the resulting average was below 0.10 in 46 cases, from 0.10 to 0.19 in 42 cases, from 0.20 to 0.49 in 21 cases, and from 0.50 up in 5 cases. *It is noteworthy that all of the five cases of a high ''Degree of Correspondence'' came from comparing yearly figures where the growth element predominates.* In the words of the author ''the correspondence is greater between price movements and the movement of money or deposits in banks or of money in circulation when the averages used cover longer periods than when they cover shorter periods.'' (P. 54.) He does not appear to recognize, however, that like growth elements in the two series make his ''Degree of Correspondence'' unreliable as a measure of the synchronization of fluctuations. (See the table given later.)

The application of the test to Kemmerer's and Fisher's figures leads Dr. Magee to the conclusion that ''in neither case is much correspondence shown for direction and amount of movement; our inference is, then, that these two attempted proofs of the Quantity Theory of Money are far from being conclusive.'' (P. 49.) Before taking the author's word for the non-conclusive character of the Kemmerer and Fisher investigations let us see how his method works in sample cases.

Suppose the method be applied to the following pair of series:

100, 150, 200, 250, 300
100, 200, 300, 400, 500

Both series are arithmetic progressions and move in the same direction. The ''Degree of Correspondence'' is ½. Now consider the pair of series below:

100, 101, 102, 103, 104, 105
100, 110, 120, 130, 140, 150

The ''Degree of Correspondence'' is but 1-10, although the items move together perfectly, *i. e.*, for an increase of one unit in the first series there is an increase of ten units in the second series. Likewise consider the following pair:

100, 101, 102, 101, 103, 100
100, 105, 110, 105, 115, 100

These series fluctuate together perfectly, *i. e.*, for a change of one unit in the first series the second changes five units in the same direction. Yet Dr. Magee's ''Degree of Correspondence'' for the pair is only 1-5. It is evident that any coefficient is possible for perfect correspondence. Dr. Magee's entire study is based upon this erratic coefficient.

The reviewer will add the following table:

Magee's method of ''Degree of Correspondence'' applied to a pair of series having the same direction of growth element, *e. g.*, series giving the relative per capita money in circulation on July 1, and the relative per capita consumption of malt liquors in the United States, 1890–1908.

(Statistical Abstract of the United States, 1909, Folder p. 19.)

Year.	Index of money in circulation.*	Index of consumption of malt liquors.†	Correspondence.		
			+	—	0
1890	90	90			
1891	93	97	.43		
1892	97	100	.75		
1893	95	106		.33	
1894	97	101		.40	
1895	92	99	.40		
1896	84	104		.62	
1897	90	98		1.00	
1898	99	105	.78		
1899	101	101		.50	
1900	106	105	.80		
1901	111	106	.20		
1902	112	115	.11		
1903	116	118	.75		
1904	122	120	.33		
1905	123	121	1.00		
1906	127	132	.36		
1907	127	139			0
1908	137	138		.10	
Totals	...	...	+5.91	—2.95	0

* Base, 1890–'99. All items multiplied by 0.9375, making the initial item identical with that of the second series.

† Base, 1890–'99.

''Degree of Correspondence,'' 1890-1908=(5.91—2.95)÷18=0.16.

''Degree of Correspondence,'' 1899-1908=(3.55—0.60)÷10=0.295.

''Degree of Correspondence,'' considering only the direction of the change for the period 1899-1908=(7—2+0)÷10=0.50.

For the ten years, 1899-1908, the ''Degree of Correspondence,'' as Dr. Magee would figure it, between per capita money in circulation and per capita consumption of malt liquors is very high, 0.50. Does this indicate that the circulation is increased by drinking alcoholic beverages, or *vice versa?*

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